Project Abstract

Ecological Boundary-Setting in Mental and Geophysical Models
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Epigram:
"[T]he future of operations research is past…..[M]anagers are not confronted with problems that are independent of each other, but with dynamic situations that consist of complex systems of changing problems that interact with each other. I call such situations *messes.* Problems are abstractions extracted from messes by analysis; …Managers do not solve problems: they manage messes," Russell Ackoff, a founder of Operations Research, 1979.

When agencies and the public direct their attention to an environmental problem, they explicitly or implicitly bound that problem by associating it with a particular system at a particular scale. We have promised in our research to learn more about problem formulation. Specifically, we have promised to look at the special role of boundary-setting in problem formulation. We start with it as given that most environmental management problems are better described as "messes," and that a-contextual analyses of ideal outcomes and algorithmic "solutions" cannot provide the guidance necessary to address these messes (epigram).

Our research will focus on the problem formulation phase of the decision process and on the role of spatial modeling in that process. The proposed research will develop and employ social science techniques for dealing with spatiality to address the general subject of problem formulation as a weak point in decision analysis. More specifically, the work will focus on the role of *perceptions* and *values* in the determination of boundaries, exploring two parallel but complementary research questions.

- How do geophysical modelers set spatio-temporal boundaries when they "model" an environmental problem?
- How do social perceptions and values of community members involved in management processes affect boundary-setting in the formulation of environmental problems?

These two parallel lines of research thus begin from different disciplinary and methodological starting points, but pursue complementary objectives—to understand the role of spatial models in problem formulation.

Two key types of values will be emphasized: (a) "sense of place values"—values that residents associate with a locality; and (b) spatial dimensions of equity issues, as private and public decisions may create differentials in the quality of life within and across physical and political boundaries. Sense of place is hypothesized in the context of experiential discounting as critical to the development of individual and social identities that frame the way environmental problems are experienced, informally bounded, and formulated. Similarly, values derived from relative social status are important in determining the spatial boundaries used to characterize environmental problems.

Three case study areas, where team members have established a research presence, have been chosen: St. Louis, MO, Chicago, IL, and Atlanta, GA. A comparative lens will be used to examine formulation of three types of environmental problems: sprawling land use patterns, management of water quality and quantity, and brownfield redevelopment.

What we need, given we are dealing with messes, is an integrative orientation that is highly contextual and comprehensive, but capable of incorporating information from the special sciences into a larger, integrated picture. Adaptive management (AM), while accepting the open-ended nature of the management problem, nevertheless promises to offer a comprehensive approach to environmental monitoring, science and decision making in the sense that it justifies taking action in the face of uncertainty through learning by doing. Although our research is just beginning, we have, in the hope of better understanding what exactly would be involved in a comprehensive, trans-disciplinary and trans-scientific approach, undertaken a broad search of the multiple literatures devoted to better understanding and guiding environmental decision making and policy development. Our goal was to "place" our research in an intellectual landscape, so we can figure out what our unique contribution can be. Table 1 represents a first try at a taxonomy of decision analyses often applied to environmental policy deliberations.

In our own work, s variety of methods will be developed and employed to study the processes by which individuals and interest groups identify, articulate, and modify perceived boundaries of environmental problems. Selected methods of garnering information about stakeholders' mental models include elicitation of perceptions through interviews, discourse analysis of documents, and revealed preference valuation. These methods will be combined with the use of agent-based GIS modeling techniques to achieve integration and to provide linkages between social scientific data and geophysical models as a way of clarifying the role of space-time boundaries in the articulation of environmental problems.

The most central split in Table 1 is between a-contextual and contextual decision-making. The former analyze outcomes by measuring some "objective" measure of behavior, such as utils or preferences (wtp), which are value measures that require—and carry with them—no information about the decision context. In our research, we will explore contextual approaches in detail, examining what initially appear to be five distinct approaches/perspectives on environmental decision making and policy. Contextual Decision Making rejects algorithmic decision tools as unlikely to serve as a comprehensive guide to decision making and seeks rationality in decision making by concentrating on <u>process</u> rather than expected outcomes

Advocates of the various forms of contextual analysis analyze processes, offer heuristics to improve problem formulation, and equate better decisions with improved problem formulation, improved understanding, and improved communication. These approaches are contextual in the sense that they recognize that local features of the decision situation are important, and that the very meaning of a real environmental problem is anchored in a **place**, which includes the physical features of a geographic location, and also the peoples who live there, and their institutions and politics.

Table 1: Contextual Models of Environmental Decision Making: A Taxonomy

A-CONTEXTUAL MODELS	***CONTEXTUAL MODELS***
Shared characteristics: -Outcome oriented -Algorithmic	Shared characteristics: -Seek Rationality in Better Process -Non-algorithmic
EXAMPLES OF A-CONTEXTUAL MODELS • Rational choice • Decision trees • CBA • Game Theory • Operations research/ optimizing	**VARIANTS ON CONTEXTUAL MODELS**

Approach	***Muddling Through***	***Cognitive Science***	***Critical Systems Theory***	***Post-positive Policy Analysis***	***Adaptive Management***
Advocates	Lindblom, Simon	Kempton, Paolisso, Bostrom et al. (risk comm.)	Ulrich, Midgeley	Lasswell, Forrester, Habermas, Dryzek, Clark	Holling Lee
Process emphasized	Negotiation and Compromise	Cognition and Learning	Epistem-ological	Policy, Decision-Making, and Political	Management
Context emphasized	Political	Learning / Deciding	Scientific and Intellectual	Whole Policy	Whole Management
Heuristic models / techniques	Bounded Rationality	Mental and Cultural Models	Boundary Critique	Problem Mapping Interpretive/ Critical analysis	Social Learning / Experiment-alism
Substance or Process?	Process and Substance Inseparable	Under-standing / Commun-ication + Improved Process	Ulrich: Substance + Process; Midgeley: Process + Method	Mainly Process Oriented	Substance + Process in action

Since we are only at the beginning of our research, and have only begun to choose techniques and methods, and to develop our interview protocols, we have as yet collected no new data. We have, however, explored the retro-active case study that was developed in the proposal where it was hypothesized that:

I: Individuals formulate and understand environmental problems (including the assumption of spatio-temporal bounds to the problem) based on mental models that reflect their personal values and context.

II: Individuals who enter public debate about the management of resources in their area as members of an interest group are likely to share with their cohorts a cultural model that bounds the public management problem faced.

III: Choices of spatial bounds (as represented in mental models of participants and researchers) have profound implications for our understanding of the problems of interest: water management, urban sprawl, and brownfield redevelopment.

IV: “Sense of place” is observable both directly and indirectly, and may often not be related to the spatial bounding selected in problem formulation.

Between1970 and 1990, Chesapeake Bay was transformed, not by natural forces or by human engineering, but through a collective act of "social learning." In the 1970s, spurred by an important EPA study and independent research, a scientific consensus emerged that, while local, point-source pollution remained important to the estuary, a more diffuse and difficult problem—the over-nutrification of the Bay from non-point sources in farmer's fields and suburban lawns—constituted a greater threat to the Bay. What ensued was a transformation of scientific and cultural models of the Bay: the perspective of Bay area residents shifted to a larger geographic and temporal scale. Careful examination of this successful process of social learning, whereby the public, politicians, and policy makers adopted a mostly-shared, watershed-sized model of the Bay, can provide clues about both boundary-setting and social learning in the face of environmental problems.

This change in perspective and viewpoint in the Chesapeake region is a case of "macroscoping"—altering a problem by embedding it in a larger-scaled system. Macroscoping—and its opposite, Microscoping—involve shifts in scale and perspective, and are hence very important in the least understood areas of decision science—problem formulation. So, as a "retroactive test case, we did a preliminary test of whether, as one would expect if our hypotheses are true, there was in fact a measurable change in the "scale" discourse about pollution in the Chesapeake Region. We found, through a content analysis of the Annapolis newspaper, that by coding references to the scale of Bay (references to Bay itself, to Bay plus tributaries, and whole watershed), we could measure a significant increase in references to larger scales between 1976 and 2000. Similarly, references in newspaper articles showed that, while references to toxic pollutants were three times more prevalent than nutrification problems in 1976, nutrification was mentioned twice as often as toxics in 2000. These very preliminary results suggest that our hypotheses are sound; we are proceeding to apply what we are learning to more contemporary case studies, as researchers are (a) using spatial economics to examine boundary effects in environmental justice research, and (b) beginning to explore the role of values and perspective in ecological modeling exercises.